

user speeds up, the friction band is eased, and the flywheel is allowed to accelerate. This system will thus automatically vary the machine speed based on the user's position without the need to make manual adjustments or input. The user can, however, adjust the machine in a number of ways to affect the intensity of the exercise, if desired. The user may turn the adjusting knobs 27 to increase or decrease the forward resistance (e.g., to simulate varying friction conditions of snow). The user may change the incline of the machine 142 to increase or decrease the intensity of the exercise. If desired, the user will also pull on the ropes or hand grips 1a, 1b in the desired fashion for upper body resistance exercise. The user may pull on the ropes in an alternating fashion, parallel fashion, using either arm alone or the user may refrain from pulling on the ropes at all. As the user expends a greater level of effort (the sum of leg backward effort and any rope-pulling), the machine will automatically adjust the amount of friction on the flywheel 17 owing to the user's movement up or down the incline of the machine, depending on the user's level of effort.

A somewhat different speed control configuration is depicted in Fig. 3. In the embodiment of Fig. 3, there is no need for the friction strap 14 to be coupled via a line to the user's clothing. Instead, the depicted friction control is based on the fact that if a user moves upward (i.e., up the incline 142) toward the front of the machine 138, the machine, although each driven roller 116a, 116b will be alternatively driven in forward 118 and reverse 122 directions, there will be greater amount of forward rotation 118 than rearward rotation 122 as the user moves up the incline.

In the embodiment of Fig. 3, a line 37 is coupled between left and right rope spools 40a, 40b which rotate with the driven rollers 116a, 116b. Line 37 runs, in order, around a left fixed pulley 35a, a movable speed control pulley 38, and a right fixed pulley 35b. The amount of line 37 which, at any one time, is not wound on the spools 40a, 40b (i.e. the amount between the spools 40a, 40b and running around pulleys 35a, 38, 35b) will be referred to as the free line. If a user is maintaining his or her level of effort and thus staying at an average fixed location on the incline, as the user reciprocates the skis left and right, the rope 37 will move from one spool to the other, with no net movement of the movable pulley 38. Furthermore, as the user moves the left ski 22a backward and the right ski 22b forward an equal amount, the line 37 will unspool from the left spool 40a, and spool a substantially equal amount onto the right spool 40b. When the user in the reciprocating motion moves the right ski 22b backward, the same amount of line 37 will spool off the right spool 40b and onto the left spool 40a. However, as the user expends a greater amount of energy, the user will move up the incline and thus on average, the forward strokes of the skis will be longer than the rearward strokes. This will result in the same amount of line 37 being unspooled from the spools 40a, 40b, causing the effective free line length from the left spool 40a to right spool 40b (not considering the amount of line on the spools) to lengthen. As the effective length of the line lengthens, the movable pulley 38 is pulled forward 314, under urging of spring 13 which relaxes somewhat causing the line 39 to pull less tightly on the friction band 14, decreasing friction on the flywheel 17. As a result, as the user moves upward up the

incline, the friction band 14 will loosen. As the user moves down the incline toward the rearmost position 136, the amount of free line will shorten, moving free pulley 38 rearwardly 312 and causing the friction band 14 to tighten.

Fig. 4 depicts another embodiment which uses a series of miter gears 44, 45 formed in a fashion similar to an automobile differential gear. With the differential gears of an automobile, (including those found in some toy automobiles) considering a car with wheels off the ground, spinning a wheel in one direction with the driveshaft locked results in the other wheel spinning in the opposite direction. Unlocking the driveshaft, as long as one wheel spins an amount equal and opposite to the other, the driveshaft remains unchanged. If both wheels spin a net amount in the same direction, the driveshaft will rotate.

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In Fig. 4, a first set of drive gears 47 are attached to the rollers 116a, 116b. These engage a second set of drive gears 43 which are connected to a set of first miter gears 44 freely riding on a gearshaft 42. A set of second miter gears 45 are mounted between the first miter gears 44 and encircled by a friction band cord spool 46. A friction band cord 39 wraps around the spool 46 and attaches to the friction band 14. When one ski goes forward and the other goes back an equal amount, the opposite spinning first miter gears 44 counter each other in an equal and opposite manner. Since skiing is an alternating activity, the gearshaft 42 driven via gear trains 412a, 412b will remain relatively still while a user is skiing in one position on the machine, i.e. moving the skis substantially the same amount forward as backward). As a result the friction band cord spool 46 remains unchanged. If the user's average position moves fore or aft on the machine, the gearshaft 42 will turn in one direction or the other. Thus, as the user moves forward or backward on the machine, the gear shaft 42 will rotate forward or backward, via the differential or miter gears 44, 45, to rotate the friction band cord spool 46, causing line 39 to loosen or tighten so as to loosen or tighten the friction band 14. As will be clear to those of skill in the art, a number of differential gear devices can be used for this purpose.

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Fig. 5 depicts an embodiment showing a number of alternative configurations. In the embodiment of Fig. 5, the user's feet, rather than being used to drive a simulated ski, instead drive a footcar 50 forward and back. The footcar 50 has wheels 49 with one-way clutches such that the footcar 50 is free to move in the forward direction (i.e., the wheel clutches are disengaged). When a footcar 50 is moved in the rearward direction, the wheels frictionally engage the inside of the surface of the conveyer belt 52 (i.e., the wheels are locked as footcar 50 is moved in the rearward direction).

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Fig. 5 also depicts another method for controlling speed by driving a flywheel shaft with a motor. Using this method negates the need to incline the machine, as the motor overcomes any internal friction. The speed of the motor can be set manually such as on a treadmill or the speed potentiometer can be tied to one of the speed controllers described above such that the machine speed is dependent on the user's position on the machine.

In the embodiment of Fig. 5, during backward motion 514 of the footcar 50, while the footcar wheels 49 are locked, the amount of resistance to the backward motion of a given footcar perceived by the user will depend principally on the amount of forward friction on the opposing footcar and the inclination 542 of the exerciser with respect to the horizontal 543.

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Without wishing to be bound by any theory, it is believed that when an exerciser is exercising on a device according to the present invention, and if there is no net or average fore-aft movement (i.e., the exerciser is substantially maintaining his or her fore-aft position) the amount of resistance to a backward leg thrust is equal to the amount of resistance to forward movement of the opposite leg. It is believed that when the device is inclined, 10 the resistance to forward movement has a contribution both from the one-way friction brake described above and resistance to movement up the incline, against gravity. During use of the device, the speed of rearward leg movement (ignoring arm exercise, for the moment) will be regulated by the speed of rotation of the flywheel which will be moving at a substantially constant speed if the user is maintaining his or her fore-aft position on the machine. It is believed that the friction band, when it is applied as described to selectively slow the flywheel, is 15 operating so as to balance the effect of gravity when the machine is inclined, in the sense that, if there were no friction band or other selective flywheel speed control, the user would tend to slide backward toward the rear-most position on the machine when the machine is inclined. It is believed that, in situations where a user moves forward or aft on the machine, there is a temporary small difference between the forward resistance and the rearward resistance.

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As noted above, during bilateral motion using the exercise device of Fig. 5, the user will tend to oscillate somewhat forward and backward (even if the user is maintaining a constant average fore-aft position with respect to the exercise machine), as the user pushes back on each leg alternately. If the machine is inclined such that the track along which the footcars move is tilted upwards 542, with each forward oscillation, the user is also lifting his 25 or her center of gravity a certain amount. The amount that the user lifts his or her center of gravity on each stride will depend not only on the length of the stride but also on the amount of inclination 542. According to one embodiment, the exercise machine can be adjusted to affect the perceived difficulty or level of activity by increasing or decreasing the inclination.

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In the depicted embodiment, the forward feet 526 are coupled to the lower frame 523 by a pivot arm 66. The pivot arm 66 can be held in any of the variety of pivot locations by adjusting the extension of link arm 528. Thus, if the user wishes to increase the inclination 542 to an inclination greater than that depicted in Fig. 5, the user may disengage the far end (not shown) of link arm 528, which may be engaged by a plurality of mechanisms including bar and hook, pin and hole, rack and pinion, latching, ratcheting or other holding mechanisms, and 35 extend the link arm 528, e.g., to the position depicted in Fig. 5A to increase the inclination of the machine to a